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AN ANALYSIS OF SEASONAL PRECIPITATION RECORDS

AS RELATED TO BLACK HILLS BEETLE OUTBREAKS

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AN ANALYSIS OF SEASONAL PRECIPITATION RECORDS AS RELATED TO BLACK HILLS BEETLE OUTBREAKS

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Outbreaks of the Black Hills beetle in the Rocky Mountain region have been associated by professional foresters and entomologists with rises and falls in precipitation. As with most discussions about weather, individuals have taken definite sides in this controversial subject, often without facts to substantiate the argument. Blackmann (1931) contended there was a direct correlation between bark moisture and brood survival. He showed that during periods of excessive moisture there was a higher survival of brood than under conditions of deficient moisture conditions. The correlations were drawn from studies of infestations on the Roosevelt and Kaibab National Forests.

Beal (1943) showed that periods of excessive and deficient moisture were reflected in tree growth and that periods of deficient moisture may have so weakened trees that they were hard put to resist attacks of the Black Hills beetle. Beal's conclusions were drawn from annual weather reports and tree ring growth studies on the various outbreaks throughout the region. Blackman's conclusions were a result of studies on a more or less seasonal basis.

The present study was made in an effort to determine the effect of seasonal precipitation on outbreaks occurring in Colorado, especially on the Roosevelt National Forest since 1920. Weather records were taken from eight weather stations occurring in the front range from northern Colorado to central Colorado. The eight stations were, Idaho Springs, Cheesman, Longs Peak, Estes Park, Moraine, Fremont Experiment Station, Monument and Fry's Ranch. Precipitation records were taken from the stations establishment to the present or until records were discontinued. Percent departure from normal was then determined from the records. Percent departure from the normal was charted for the following periods: January through April, Chart No. 1; May and June, Chart No. 2; July, Chart No. 3; August, Chart No. 4; Annual, Chart No. 5. The precipitation was charted in this manner as it was thought that the precipitation in months listed was more likely to be reflected in tree growth. The outbreaks occurring from 1910 through 1947 were then correlated with precipitation departure.

In studies of this sort we are at a disadvantage in knowing when outbreaks started. It is highly possible that the start of any outbreak occurs one or two years before discovery. Therefore, it is quite difficult to correlate outbreaks and seasonal precipitation, especially when the seasonal precipitation varies so tremendously from year to year as it does in this region. Assuming that this premise is true, no direct correlation can be drawn between excessive and deficient amounts of precipitation and bark beetle attacks. An examination of the charted precipitation reveals the following: The outbreak which was charted as of 1923-30 started when the annual precipitation in January - April of 1922 was approximately 2 percent above normal and the precipitation in the same months for 1921 was 86 percent above normal. Assuming the same one or two year lag in discovery of the infestation, the epidemic charted as beginning in 1933 occurred when the precipitation for the 4 month period was between 10 and 20 percent below normal. The infestation charted as starting in 1944, if undiscovered for a year, began when the precipitation was between 25 and 30 percent below normal. If the discovery was two years late then the infestation started when the precipitation was 9% percent above normal. An examination of the other charts on seasonal precipitation included in the report will show the same discrepancies. Chart No. 5 which plots the precipitation departure on an annual basis is the only one that reveals a consistent trend in epidemic occurrences. All infestations based on a years lag in discovery occurred during years when moisture was deficient by from 10 to 25 percent.

Assuming that the outbreaks were discovered the year that they began, the discrepancies during the periods recorded are just as great. One outbreak starting during periods of deficient moisture, the others during periods of excessive moisture.

During the study an effort was made to correlate tree growth with seasonal precipitation. The tree growth measurements were taken from the study by J. A. Beal (1943). The results of this effort are illustrated in the following tables.

TABLE NO. 1. DEPARTURE FROM NORMAL
TREE GROWTH AND PRECIPITATION
Jan. - April, 1915-1939

Year	Tree Growth Departure from normal in thousandths of inches	Precipitation Percent Departure
1915	+ 32	+ 29
1916	+ 19	+ 21
1917	+ 9	- 5
1918	+ 9	+ 30
1919	- 17	- 13
1920	- 7	+ 41
1921	+ 11	+ 86
1922	- 25	+ 2
1923	+ 12	- 10
1924	- 16	- 4
1925	- 28	- 69
1926	- 10	+ 40
1927	- 16	- 6
1928	- 5	- 15
1929	- 21	- 35
1930	- 21	- 40
1931	- 31	- 9
1932	- 52	- 19
1933	- 34	+ 29
1934	- 50	- 5
1935	- 34	- 32
1936	- 40	- 31
1937	- 38	- 22
1938	- 10	+ 18
1939	- 3	- 29

TABLE NO. 2. DEPARTURE FROM NORMAL
TREE GROWTH AND PRECIPITATION
May - June, 1915-1939

Year	Tree Growth Departure from normal in thousandths of inches	Precipitation Percent Departure
1915	+ 32	+ 25
1916	+ 19	- 41
1917	+ 9	+ 10
1918	+ 9	+ 12
1919	- 17	- 55
1920	- 7	- 31
1921	+ 11	+ 49
1922	- 25	- 43
1923	+ 12	+ 55
1924	- 16	- 12
1925	- 28	- 15
1926	- 10	+ 2
1927	- 16	+ 20
1928	+ 5	+ 37
1929	- 21	- 35
1930	- 21	- 32
1931	- 31	+ 25
1932	- 52	- 31
1933	- 34	- 22
1934	- 50	- 24
1935	- 34	+ 35
1936	- 40	- 9
1937	- 38	+ 40
1938	- 10	+ 30
1939	- 3	- 53

TABLE NO. 3. DEPARTURE FROM NORMAL
TREE GROWTH AND PRECIPITATION
July, 1915-1939

Year	Tree Growth Departure from normal in thousandths of inches	Precipitation Percent Departure
1915	+ 32	- 45
1916	+ 19	+ 21
1917	+ 9	- 4
1918	+ 9	+ 19
1919	- 17	0
1920	- 7	- 20
1921	+ 11	+ 21
1922	- 25	- 11
1923	+ 12	+ 95
1924	- 16	- 29
1925	- 28	+ 21
1926	- 10	+ 12
1927	- 16	- 1
1928	- 5	+ 4
1929	- 21	+ 75
1930	- 21	+ 13
1931	- 31	- 45
1932	- 52	+ 31
1933	- 34	- 42
1934	- 50	- 52
1935	- 34	- 15
1936	- 40	- 23
1937	- 38	- 21
1938	- 10	- 42
1939	- 3	- 60

TABLE NO. 4. DEPARTURE FROM NORMAL
TREE GROWTH AND PRECIPITATION
August, 1915-1939

Year	Tree Growth Departure from normal in thousandths of inches	Precipitation Percent Departure
1915	+ 32	+ 55
1916	+ 19	+ 10
1917	+ 9	- 15
1918	+ 9	- 35
1919	- 17	- 25
1920	- 7	+ 27
1921	+ 11	+ 55
1922	- 25	+ 30
1923	+ 12	+ 19
1924	- 16	- 70
1925	- 28	+ 51
1926	- 10	0
1927	- 16	+ 45
1928	- 5	+ 61
1929	- 21	+ 49
1930	- 21	+ 96
1931	- 31	- 32
1932	- 52	- 29
1933	- 34	- 21
1934	- 50	+ 13
1935	- 34	+ 15
1936	- 40	+ 20
1937	- 38	- 18
1938	- 10	+ 53
1939	- 3	- 41

There seems to be very little correlation between tree growth and seasonal precipitation records. It is interesting to note, however, that tree growth was below normal from 1923 through 1939 on the Roosevelt National Forest. It is also interesting to note that although there are a few discrepancies, tree growth is more closely associated with precipitation which occurs in the 4 month period beginning with January and ending with April than with any other season.

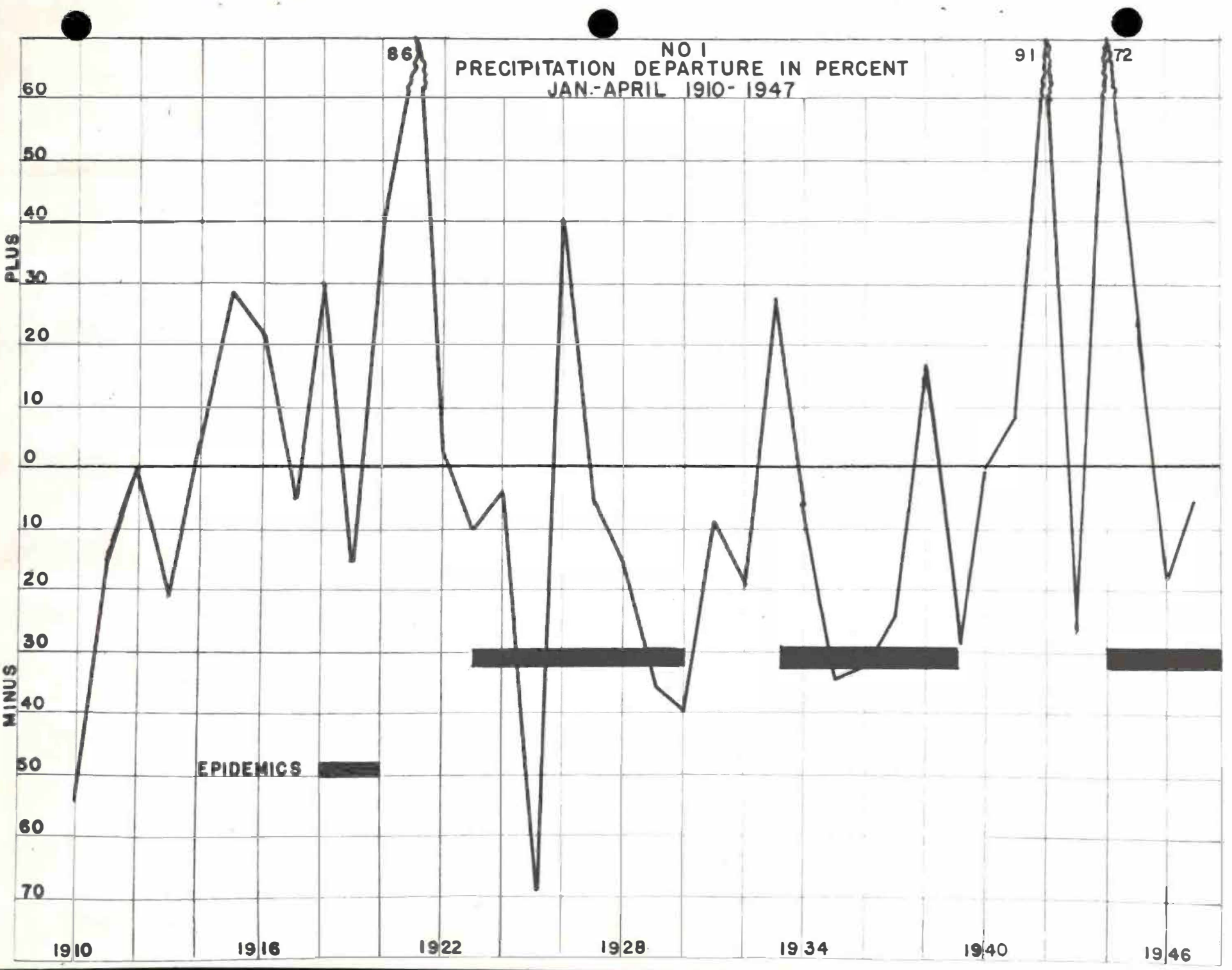
As has been noted before, little can be drawn from the data recorded. Further study is needed to determine the exact relationship between tree growth and precipitation. Precipitation records on a daily or weekly basis might offer more concrete information. It is very possible that the precipitation for a given month could occur in a few days, or a few hours, with a great deal of runoff. Precipitation coming in such a manner in the summer months would be for the most part unavailable to the tree.

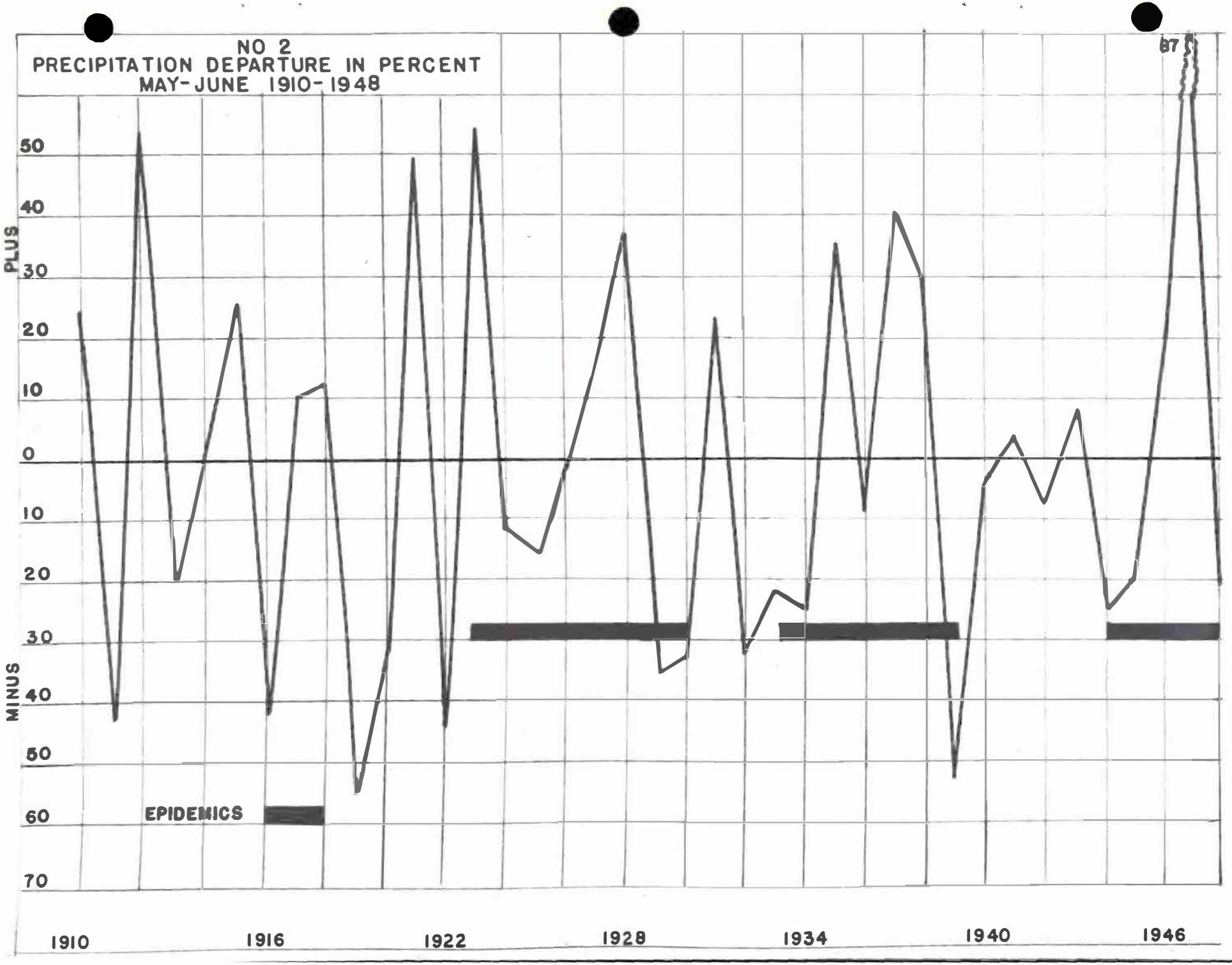
At present it appears that the only practical method of establishing the relationship between beetle outbreaks, precipitation, and tree growth, is a method which will record the precipitation in heavily infested areas together with cyclical changes in beetle population.

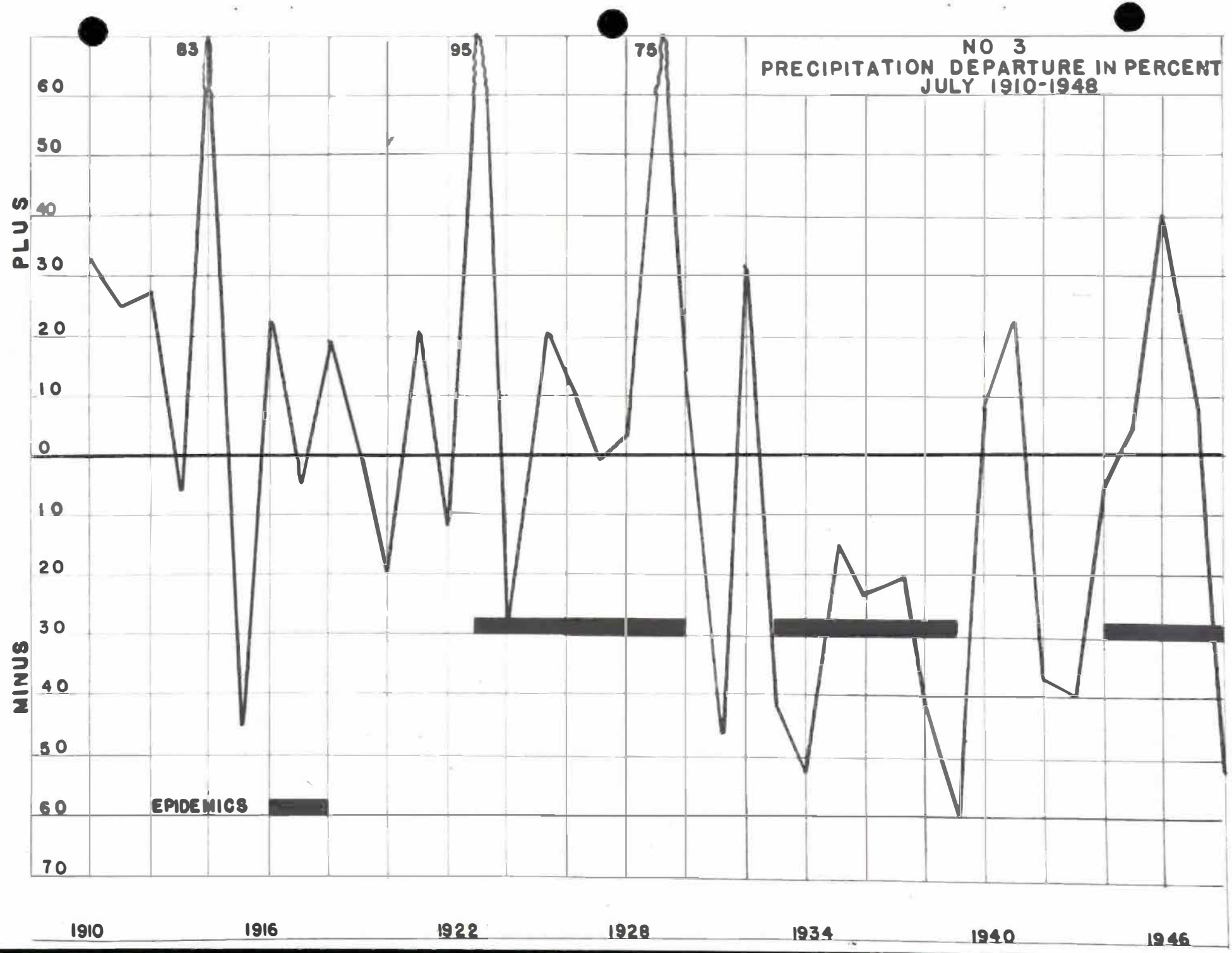
Literature Cited

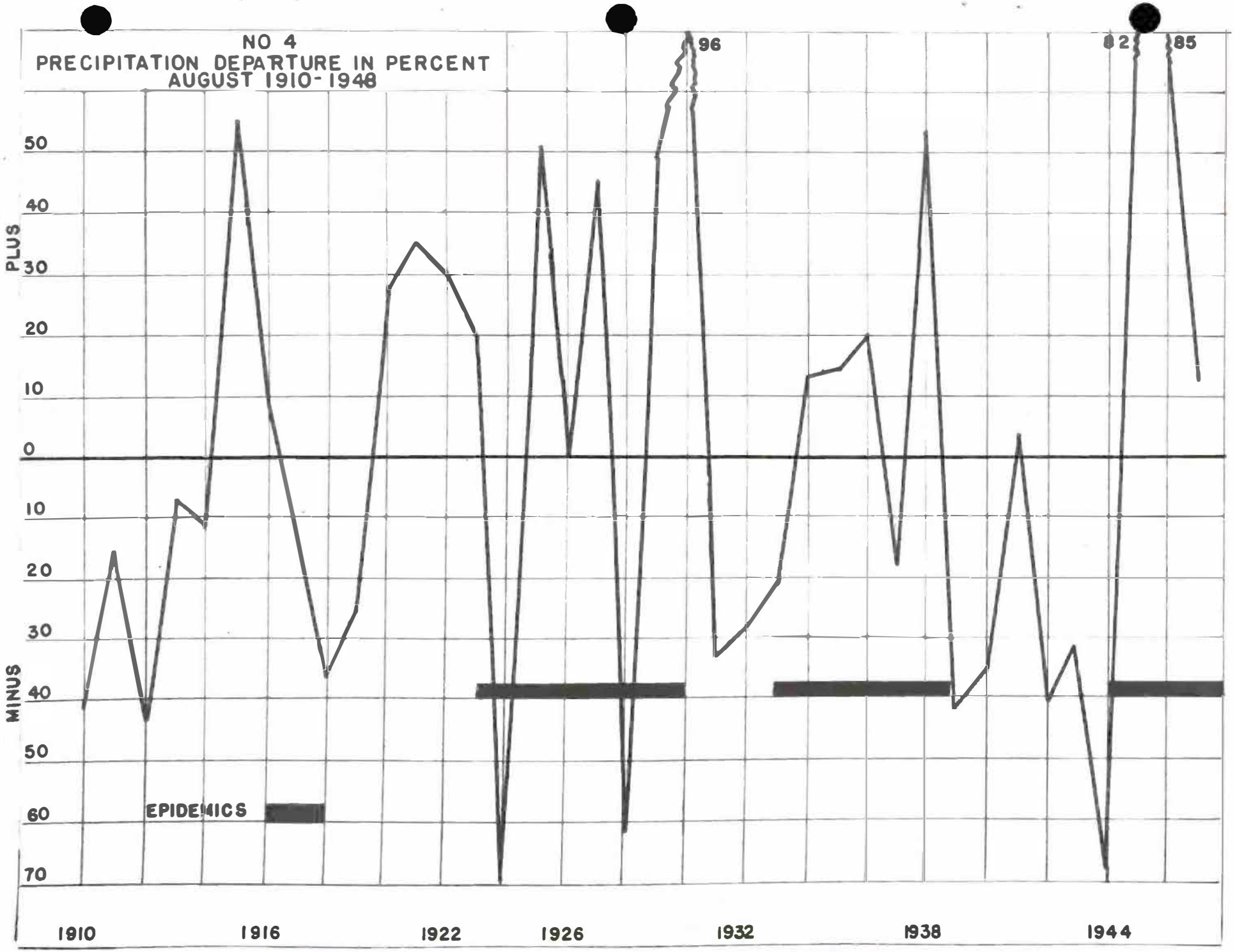
(1931) Blackman, M. W. The Black Hills Beetle. N. Y. State College of Forestry Tech. Pub. No. 36, Vol. IV, No. 4.

(1943) Beal, J. A. Relation Between Tree Growth and Outbreaks of the Black Hills Beetle. Journal of Forestry, Vol. 41, No. 5, May 1943.


NO 1
PRECIPITATION DEPARTURE IN PERCENT
JAN.-APRIL 1910- 1947
86
91
72
PLUS
MINUS
60
50
40
30
20
10
0
10
20
30
40
50
60
70
EPIDEMICS
1910
1916
1922
1928
1934
1940
1946


NO 2
PRECIPITATION DEPARTURE IN PERCENT
MAY-JUNE 1910-1948
87
50
40
30
20
10
0
10
20
30
40
50
60
70
PLUS
MINUS
EPIDEMICS
1910
1916
1922
1928
1934
1940
1946


NO 3
PRECIPITATION DEPARTURE IN PERCENT
JULY 1910-1948
83
95
75
PLUS
MINUS
60
50
40
30
20
10
0
10
20
30
40
50
60
70
EPIDEMICS
1910
1916
1922
1928
1934
1940
1946


NO 4
PRECIPITATION DEPARTURE IN PERCENT
AUGUST 1910-1948
96
82
85
PLUS
MINUS
50
40
30
20
10
0
10
20
30
40
50
60
70
EPIDEMICS
1910
1916
1922
1926
1932
1938
1944

NO 5

PRECIPITATION DEPARTURE IN PERCENT
ANNUAL 1910-1947